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**CONTINUOUS EVALUATION OF  
CORRUGATING MEDIUM**

✓ Project 1108-17

Progress Report Ten

to

**FOURDRINIER KRAFT BOARD INSTITUTE, INC.**

August 1, 1956

THE INSTITUTE OF PAPER CHEMISTRY

Appleton, Wisconsin

CONTINUOUS EVALUATION OF CORRUGATING MEDIUM

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### CONTINUOUS EVALUATION OF CORRUGATING MEDIUM

The purpose of this study is to provide a continuous evaluation of the quality and runability of corrugating medium produced by members of the Fourdrinier Kraft Board Institute. The study, as it progresses, will accumulate a backlog of data and experience which will provide two important benefits. First, it will enable each participant to evaluate his position in relation to the rest of the industry. Second, it will provide information essential for the interpretation of any proposed specifications on corrugating medium (on either a company or industry basis).

The procedure for participating in this study involves the submission of two rolls of corrugating medium per week from each machine to The Institute of Paper Chemistry. These rolls are taken from regular production runs on different days. Each roll is 10 to 12 inches wide and contains approximately 2,500 lineal feet of medium (approximately 20 inches in diameter). Each roll as it is received by the Institute is assigned a code letter and number. The rolls are numbered in the sequence in which they are received. Code letters are assigned on the basis of machines and a given machine is assigned a different code letter each month in order to mask the identity of the mills. For purposes of reference, a copy of the outline of the program together with the necessary instructions for sampling was appended to Progress Report One in this series.

During the month of July, sixty-one different sample lots of corrugating medium were submitted from the production of twelve machines to The Institute of Paper Chemistry for evaluation. A tabulation of the samples classified according to machines may be seen in Table I.

TABLE I  
DISTRIBUTION OF CORRUGATING MEDIUM SAMPLES

Machine Code	Number of Samples
A	2
B	7
C	7
D	8
E	7
F	8
G	1
H	2
I	6
J	8
K	0
L	3
M	<u>2</u>
Total	61

Each sample of corrugating medium was evaluated for basis weight, caliper, Concora flat crush, H. and D. flat crush (single-faced board), and runability. Runability was measured by corrugating each roll under standardized conditions on the Institute's corrugator into A-flute board at 600 feet per minute. If unsatisfactory runability occurred at this speed, the corrugator was slowed down in increments of 25 f.p.m. until satisfactory runability was obtained (no ruptured flutes). As indicated above, flat crush was determined on the combined board, thereby providing data which may be useful in studying the relationship between

Concora flat crush and combined board flat crush for each participant's medium.

As requested by members of the F.K.B.I., the Concora medium test results are calculated on the basis of pounds of load per unit area rather than on the basis of the formula suggested by the Concora manufacturer and are reported as Concora flat crush test results. In Progress Reports One and Two, the Concora medium test results were reported on the basis of the formula suggested by the Concora manufacturer.

The average test results obtained on the samples of corrugating medium submitted by each participant during July are shown in Table II and graphically presented in Figures 1 to 4. In addition to a comparison of the test data obtained for the various machines, Table II also presents the current F.K.I. averages, cumulative K.K.I. averages, and the F.K.I. indexes. The current F.K.I. average is the average test result for all machines participating in the study during a given month. The cumulative F.K.I. average is based on the results for the previous months excluding the result for the current period. The F.K.I. index is obtained as follows:

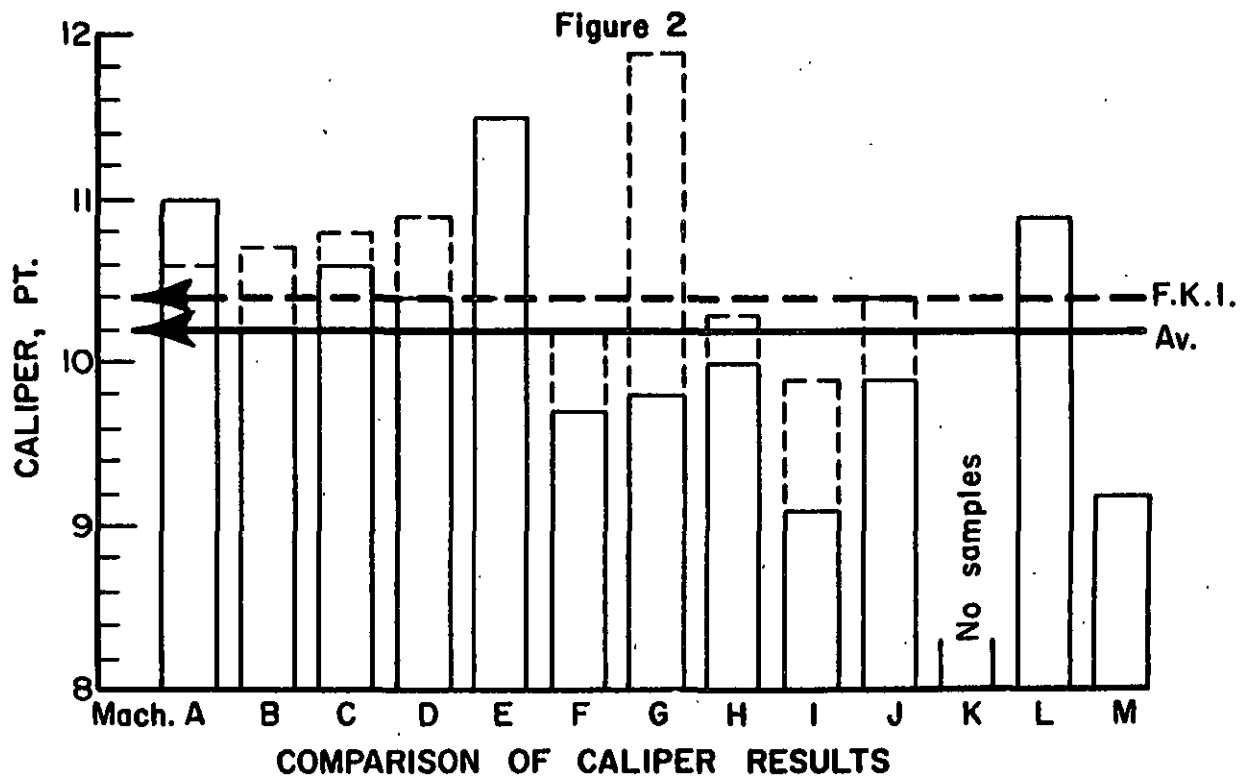
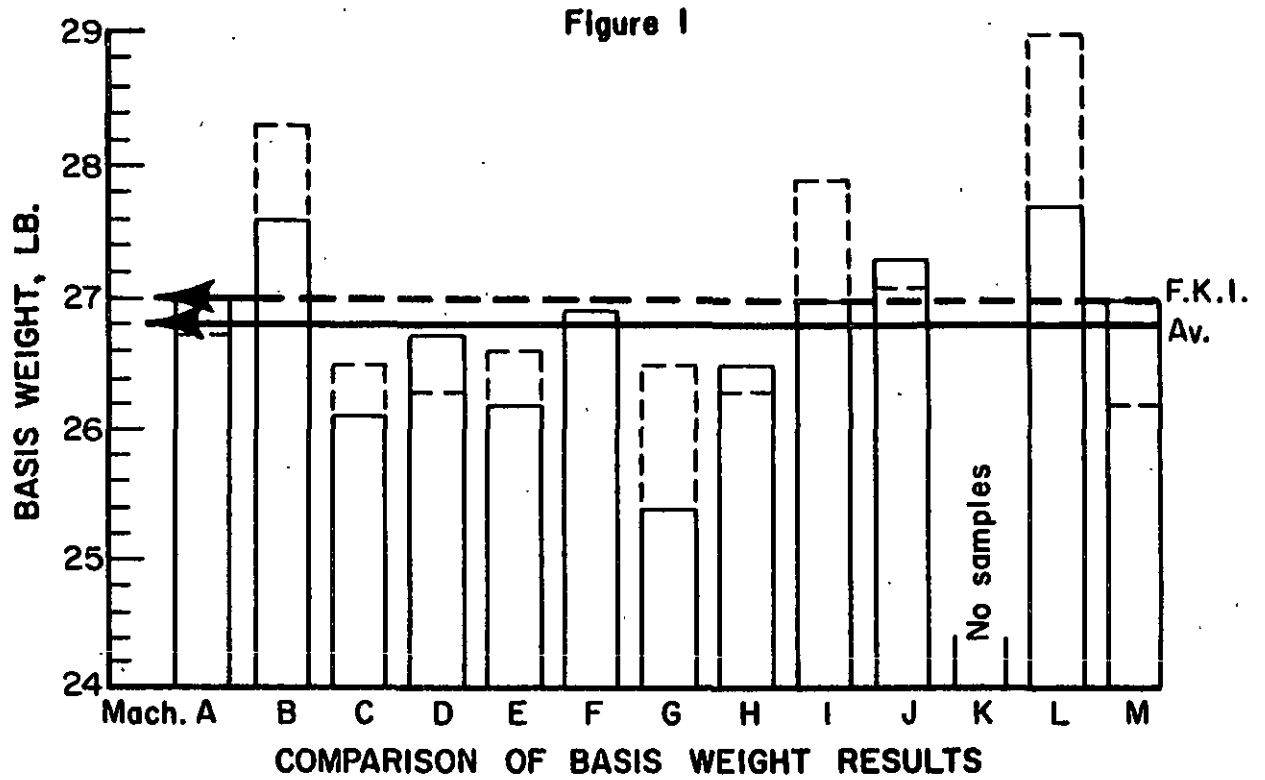
$$\frac{\text{current F.K.I. average}}{\text{cumulative F.K.I. average}} \times 100 = \text{F.K.I. index (\%)}$$

The F.K.I. index provides a ready means of comparing the current quality with previous results. An index greater than 100% indicates that current quality is higher than the average result for the previous periods; an index below 100% indicates that current quality is lower than the average result for the previous periods.

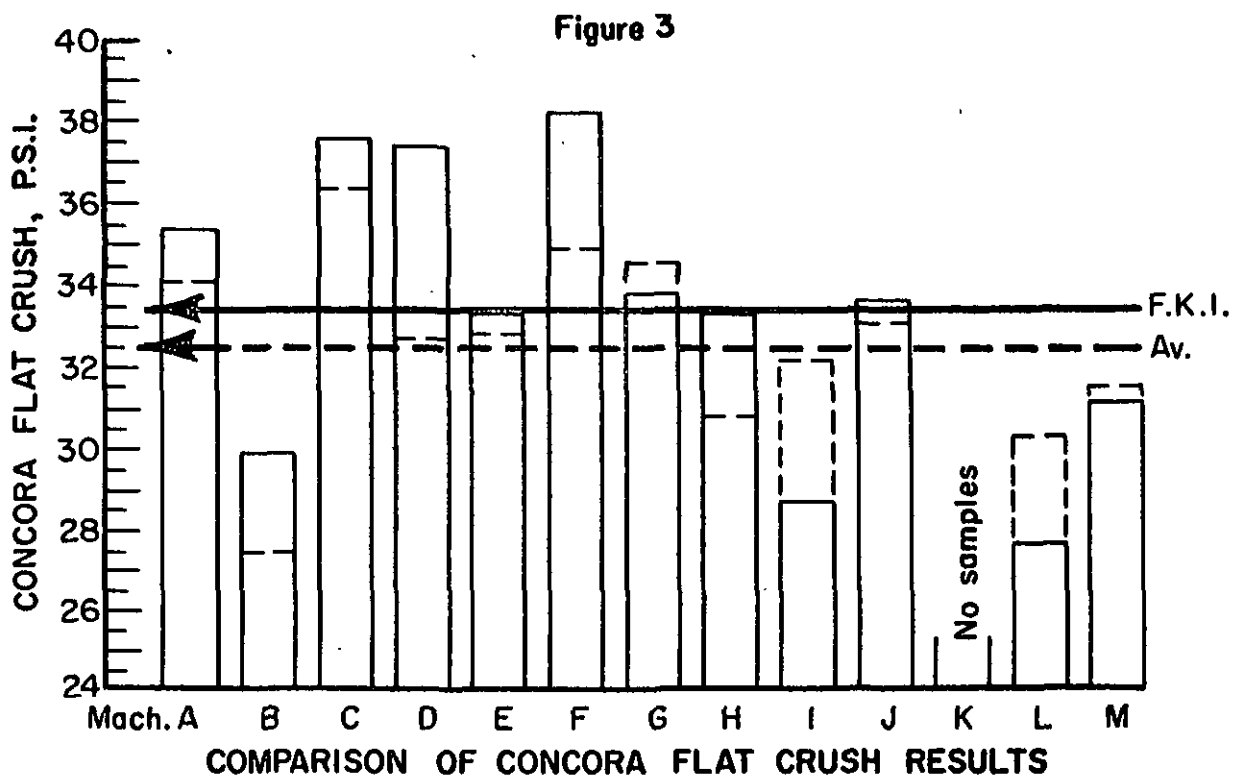
TABLE II  
SUMMARY OF CURRENT MACHINE AVERAGES

July, 1956

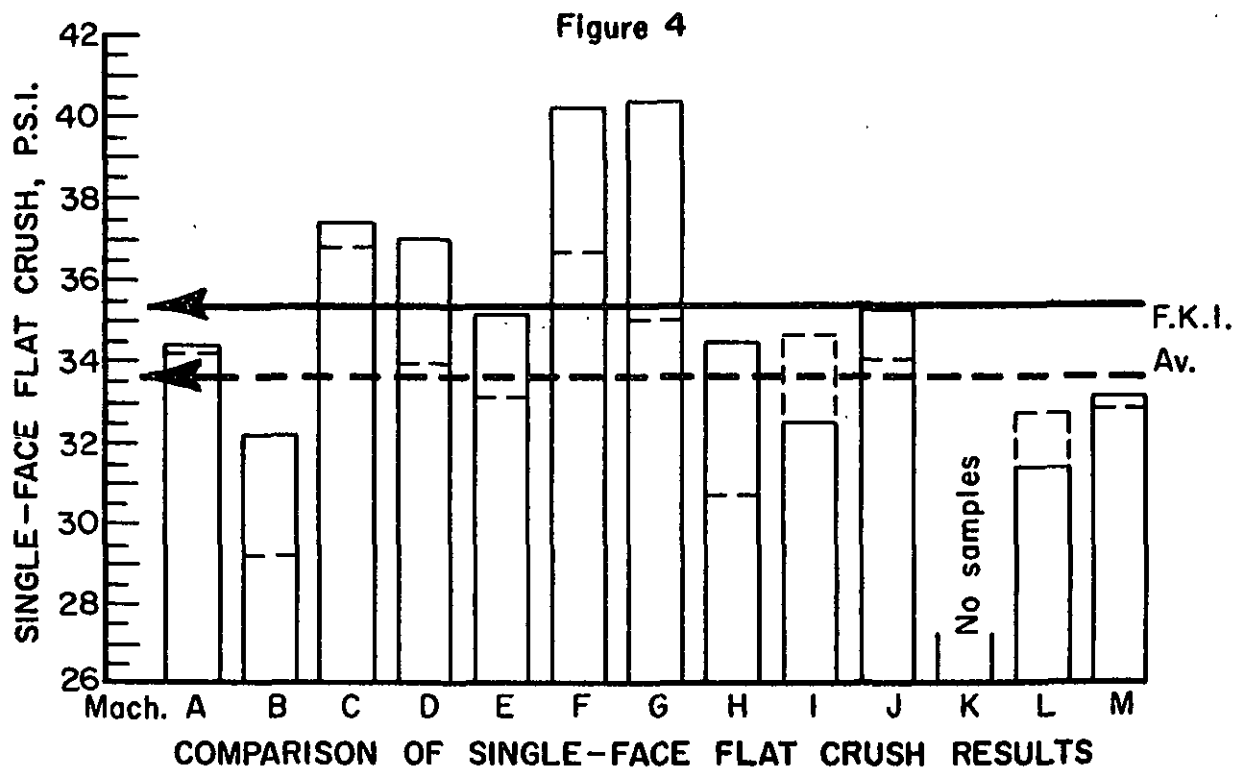
Code	Basis Weight, lb.	Caliper, points	Co cora Flat Crush, p.s.i.	Single-Face Flat Crush, p.s.i.
A	27.9	11.0	35.4	34.4
B	27.6	10.2	29.9	32.2
C	26.1	10.6	37.6	37.4
D	26.7	10.4	37.4	37.0
E	26.2	11.5	33.3	35.1
F	26.9	9.7	38.2	40.2
G	25.4	9.8	33.8	40.4
H	26.5	10.0	33.3	34.5
I	27.0	9.1	28.7	32.5
J	27.3	9.9	33.7	35.2
K	No samples submitted.			
L	27.7	10.9	27.7	31.4
M	27.0	9.2	31.2	33.1
Current F.K.I. Average	26.8	10.2	33.4	35.3
Cumulative F.K.I. Average	27.0	10.4	32.5	33.6
F.K.I. Index, %	99.0	97.8	102.7	105.0



— Current machine average  
- - - Cumulative machine average



July, 1956



July, 1956

— Current machine average  
- - - Cumulative machine average



The test results obtained on the sample lots submitted from the production of each of the machines are shown in Tables III through XV for Machines A through M, respectively. The maximum, minimum, and average test results obtained on each sample lot are shown for all tests except basis weight for which only the average is shown; in addition, the over-all average result for all the sample lots submitted for each machine is shown for each test. The latter over-all averages are reported as "current machine averages." A cumulative machine average is also shown and is calculated by averaging the current machine averages for the previous periods (excluding the current period). Also shown for each machine in Tables III to XVI are the machine factor and machine index which are defined as follows:

$$\frac{\text{current machine average}}{\text{cumulative machine average}} \times 100 = \text{machine factor (\%)}$$

$$\frac{\text{current machine average}}{\text{cumulative F.K.I. average}} \times 100 = \text{machine index (\%)}$$

The machine factor and machine index provide a means for comparing the current machine average with either the previous results for that particular machine or with the cumulative results for all machines--i.e., the cumulative F.K.I. average.

In Table II the current machine averages for the month of July are summarized. It may be noted that basis weight varied from a low of 25.4 lb. for Machine G to a high of 27.7 lb. for Machine L. The average basis weight for the twelve participating machines (current F.K.I. average) was 26.8 lb. per 1000 sq. ft., only slightly lower than the

cumulative F.K.I. average of 27.0 lb. as indicated by the F.K.I. index of 99.0%. The average results for all machines except G satisfy the requirements of Rule 41.

Caliper results varied from a low value of 9.1 for Machine I to a high value of 11.5 for Machine E. The current F.K.I. average for caliper was 10.2 points, somewhat lower than the cumulative F.K.I. average of 10.4 points. The average caliper results for all machines meet the Rule 41 specification.

Concora flat crush test results ranged from a minimum of 27.7 p.s.i. for Machine L to a maximum of 38.2 p.s.i. for Machine F. The current F.K.I. average was 33.4 p.s.i., somewhat higher than the cumulative F.K.I. average of 32.5 p.s.i. as indicated by the F.K.I. index of 102.7%.

Machine G had the highest average single-face flat crush of 40.4 p.s.i. and Machine L had the lowest, 31.4 p.s.i. The current F.K.I. average for flat crush was 35.3 p.s.i., whereas the cumulative F.K.I. average was 33.6 p.s.i., giving an F.K.I. index of 105.0%.

For the current period, the current F.K.I. averages for Concora flat crush and single-face flat crush exceeded their respective cumulative averages, whereas the current F.K.I. averages for basis weight and caliper were slightly lower than the corresponding cumulative averages.

TABLE III  
SUMMARY OF TEST RESULTS FOR MACHINE A

Code	Date Made	Date Recd.	Mill Roll No.	Basis Weight, lb. per 1000 sq. ft.	Caliper, points			Concora Flat Crush, Single-Face Flat Crush, p.s.i.			Runability
					Max.	Min.	Av.	Max.	Min.	Av.	
A-1	7-17-56	7-20-56	69	26.8	11.1	10.7	10.9	38.3	34.7	36.6	Satisfactory at 600 f.p.m.
A-2	7-20-56	7-23-56	70	27.1	11.5	10.9	11.1	37.1	31.7	34.3	Satisfactory at 600 f.p.m.
Current Machine Average:				27.0			11.0	35.4		34.4	
Cumulative Machine Average:				26.7			10.6	34.1		34.2	
Machine Factor, %:				101.0			103.8	104.0		100.4	
Machine Index, %:				99.6			105.7	109.2		102.3	

TABLE IV  
SUMMARY OF TEST RESULTS FOR MACHINE B

Code	Date Made	Date Recd.	Mill Roll No.	Basis Weight, lb. per 1000 sq. ft.	Caliper, points			Concora Flat Crush, Single-Face Flat Crush, p.s.i.			Runability
					Max.	Min.	Av.	Max.	Min.	Av.	
B-1	--	6-25-56	61	27.9	11.1	10.5	10.9	28.7	27.5	28.1	Satisfactory at 575 f.p.m.
B-2	--	6-25-56	62	26.8	10.2	9.8	10.0	33.5	29.3	31.6	Satisfactory at 600 f.p.m.
B-3	6-19-56	6-29-56	63	27.4	11.0	10.4	10.7	31.1	24.0	26.2	Satisfactory at 600 f.p.m.
B-4	6-27-56	7- 5-56	64	27.5	10.5	9.5	9.9	32.3	31.7	31.9	Satisfactory at 600 f.p.m.
B-5	6-29-56	7- 6-56	65	27.4	10.4	9.8	10.0	36.5	31.7	33.4	Satisfactory at 600 f.p.m.
B-6	7-13-56	7-19-56	66	27.8	10.0	9.0	9.7	31.1	25.7	27.9	Satisfactory at 600 f.p.m.
B-7	7-14-56	7-19-56	67	28.7	10.8	10.0	10.2	31.1	29.3	30.3	Satisfactory at 600 f.p.m.
Current Machine Average:				27.6			10.2	29.9		32.2	
Cumulative Machine Average:				28.3			10.7	27.5		29.2	
Machine Factor, %:				97.5			95.6	108.7		110.6	
Machine Index, %:				102.2			97.9	92.1		95.9	

TABLE V  
SUMMARY OF TEST RESULTS FOR MACHINE C

July, 1956

Code	Date Made	Date Recd.	Mill Roll No.	Basis Weight, lb. per 1000 sq. ft.	Caliper, points		Concord Flat Crush, P.S.I.		Single-Face Flat Crush, P.S.I.		Runability
					Max.	Min.	Max.	Min.	Max.	Min.	
C-1	6-20-56	6-25-56	141	25.4	10.9	9.9	38.9	33.5	36.9	38.4	Satisfactory at 600 f.p.m.
C-2	6-22-56	6-28-56	142	25.4	11.0	10.1	37.1	34.7	36.0	35.0	Satisfactory at 600 f.p.m.
C-3	6-29-56	7-3-56	145	26.9	11.8	10.4	38.9	34.7	36.3	38.0	Satisfactory at 600 f.p.m.
C-4	7-3-56	7-6-56	147	26.0	11.5	10.5	34.7	30.5	33.5	36.2	Satisfactory at 600 f.p.m.
C-5	7-10-56	7-16-56	149	26.1	10.9	10.0	42.5	38.3	40.7	40.8	Satisfactory at 600 f.p.m.
C-6	7-13-56	7-17-56	152	26.8	10.9	10.0	42.5	38.9	41.0	43.0	Satisfactory at 600 f.p.m.
C-7	7-17-56	7-23-56	154	26.0	11.0	10.0	41.3	35.3	38.4	40.2	Satisfactory at 600 f.p.m.
Current Machine Average:				26.1	10.6		37.6		37.4		
Cumulative Machine Average:				26.5	10.8		36.3		36.8		
Machine Factor, %:				98.7	98.2		103.4		101.6		
Machine Index, %:				96.5	101.4		115.6		111.2		

TABLE VI  
SUMMARY OF TEST RESULTS FOR MACHINE D

July, 1956

Code	Date Made	Date Recd.	Mill Roll No.	Basis Weight, lb. per 1000 sq. ft.	Caliper, points		Concora Flat Crush, p.s.i.		Single-Face Flat Crush, p.s.i.		Runability
					Max.	Min.	Max.	Min.	Max.	Min.	
D-1	6-20-56	6-25-56	140	26.3	10.8	9.2	40.7	34.7	39.6	35.8	37.2
D-2	6-22-56	6-28-56	143	26.2	10.9	10.0	37.1	34.1	39.4	35.4	37.9
D-3	6-27-56	7-2-56	144	26.8	10.7	10.0	37.7	31.1	37.0	34.0	35.4
D-4	6-29-56	7-3-56	146	27.4	10.5	9.7	44.3	36.9	40.8	39.6	40.1
D-5	7-3-56	7-6-56	148	26.5	12.2	10.5	35.9	32.3	35.2	32.8	34.3
D-6	7-10-56	7-16-56	150	26.5	11.0	10.0	39.5	35.3	36.2	33.2	35.1
D-7	7-13-56	7-17-56	151	26.9	11.0	10.0	39.5	38.3	39.8	37.8	38.4
D-8	7-17-56	7-23-56	153	26.7	10.2	9.8	39.5	35.3	39.0	36.4	37.8
Current Machine Average:				26.7	10.4		37.4		37.0		
Cumulative Machine Average:				26.3	10.9		32.7		33.9		
Machine Factor, %:				101.6	95.3		114.3		109.1		
Machine Index, %:				98.8	99.4		115.2		110.2		

TABLE VII  
SUMMARY OF TEST RESULTS FOR MACHINE E

July, 1956

Code	Date Made	Date Recd.	Mill Roll No.	Basis Weight, lb. per 1000 sq. ft.	Caliper, points		Concora Flat Crush, p.s.i.		Single-Face Flat Crush, p.s.i.		Runability			
					Max.	Min.	Max.	Min.	Max.	Min.				
E-1	6-22-56	6-25-56	70	26.3	12.1	10.9	11.5	33.5	27.5	30.5	36.2	33.8	34.8	Satisfactory at 600 f.p.m.
E-2	6-26-56	6-29-56	71	25.6	12.0	11.0	11.5	35.3	29.9	32.3	35.2	32.8	34.0	Satisfactory at 600 f.p.m.
E-3	6-28-56	7-2-56	72	25.0	11.0	10.4	10.7	30.5	26.3	29.2	37.6	33.8	35.7	Satisfactory at 600 f.p.m.
E-4	7-3-56	7-6-56	73	27.2	12.5	11.0	11.8	37.1	31.1	34.4	35.4	33.2	34.4	Satisfactory at 600 f.p.m.
E-5	7-5-56	7-9-56	74	26.5	12.6	11.2	12.0	35.9	30.5	32.7	36.0	33.0	34.6	Satisfactory at 600 f.p.m.
E-6	7-10-56	7-13-56	75	26.1	11.8	10.9	11.2	37.1	33.5	35.4	37.2	34.6	35.7	Satisfactory at 600 f.p.m.
E-7	7-12-56	7-16-56	76	26.8	12.8	11.0	12.0	40.7	36.5	38.4	37.8	35.4	36.4	Satisfactory at 600 f.p.m.
Current Machine Average:				26.2	11.5		33.3		35.1					
Cumulative Machine Average:				26.6	10.4		32.8		33.1					
Machine Factor, %:				98.7	110.8		101.6		106.1					
Machine Index, %:				96.9	110.7		102.5		104.4					

TABLE VIII  
SUMMARY OF TEST RESULTS FOR MACHINE F

July, 1956

Code	Date Made	Date Recd.	Mill Roll No.	Basis Weight, lb. per 1000 sq. ft.	Caliper, points		Concora Flat Crush, p.s.i.		Single-Face Flat Crush, p.s.i.		Runability
					Max.	Min.	Max.	Min.	Max.	Min.	
F-1	6-17-56	6-25-56	73	27.1	11.0	10.0	40.7	37.7	41.2	38.2	Satisfactory at 600 f.p.m.
F-2	6-26-56	7-2-56	74	26.0	9.6	9.3	40.1	35.9	45.0	41.0	Satisfactory at 600 f.p.m.
F-3	6-28-56	7-9-56	75	26.5	9.9	9.1	38.9	36.5	40.4	37.4	Satisfactory at 600 f.p.m.
F-4	7-3-56	7-9-56	76	27.0	9.9	9.0	38.9	35.9	42.0	38.6	Satisfactory at 600 f.p.m.
F-5	7-5-56	7-9-56	77	27.1	10.2	9.1	38.3	33.5	40.4	38.2	Satisfactory at 600 f.p.m.
F-6	7-10-56	7-16-56	78	26.5	10.0	9.1	41.9	38.3	42.4	40.0	Satisfactory at 600 f.p.m.
F-7	7-13-56	7-20-56	79	27.0	10.0	9.0	40.7	36.5	41.8	38.8	Satisfactory at 600 f.p.m.
F-8	7-15-56	7-20-56	80	27.7	9.6	9.0	41.3	40.1	40.4	37.8	Satisfactory at 600 f.p.m.
Current Machine Average:				26.9	9.7		38.2		40.2		
Cumulative Machine Average:				26.9	10.2		34.9		36.7		
Machine Factor, %:				100.0	94.8		109.6		109.6		
Machine Index, %:				99.3	93.2		117.8		119.7		

TABLE IX  
SUMMARY OF TEST RESULTS FOR MACHINE G

July, 1956														
Code	Date Made	Date Recd.	Mill Roll No.	Basis Weight, lb. per 1000 sq. ft.	Caliper, points		Concora Flat Crush, p.s.i.		Single-Face Flat Crush, p.s.i.		Runability			
					Max.	Min.	Av.	Max.	Min.	Av.		Max.	Min.	Av.
G-1	7-3-56	7-18-56	--	25.4	10.5	9.0	9.8	36.5	30.5	33.8	41.0	39.2	40.4	Satisfactory at 600 f.p.m.
Current Machine Average:				25.4			9.8			33.8			40.4	
Cumulative Machine Average:				26.5			11.9			34.6			35.0	
Machine Factor, %:				95.9			82.8			97.5			115.3	
Machine Index, %:				94.0			94.2			104.0			120.1	

TABLE X  
SUMMARY OF TEST RESULTS FOR MACHINE H

H-1	--	7-11-56	8	26.5	10.5	10.0	10.1	34.7	32.3	33.7	34.8	32.2	33.8	Satisfactory at 600 f.p.m.
H-2	--	7-11-56	9	26.5	10.5	9.5	10.0	34.1	31.7	32.9	36.6	34.0	35.2	Satisfactory at 600 f.p.m.
Current Machine Average:				26.5		10.0			33.3				34.5	
Cumulative Machine Average:				26.3		10.3			30.8				30.7	
Machine Factor, %:				100.9		98.0			108.3				112.2	
Machine Index, %:				98.0		96.4			102.5				102.6	



TABLE XI  
SUMMARY OF TEST RESULTS FOR MACHINE I

July, 1956

Code	Date Made	Date Recd.	Mill Roll No.	Basis Weight, lb. per 1000 sq. ft.	Caliper, points		Concora Flat Crush, p.s.i.		Single-Face Flat Crush, p.s.i.		Runability			
					Max.	Min.	Av.	Max.	Min.	Av.				
I-1	--	6-25-56	--	26.5	9.8	8.9	9.2	30.5	28.7	34.8	34.0	34.4	Satisfactory at 600 f.p.m.	
I-2	--	6-26-56	--	26.3	9.0	8.1	8.8	33.5	28.7	30.8	32.4	33.8	Satisfactory at 600 f.p.m.	
I-3	6-25-56	6-29-56	--	26.6	9.9	8.9	9.2	28.7	26.3	28.0	34.0	29.4	31.6	Satisfactory at 600 f.p.m.
I-4	6-25-56	6-29-56	--	26.6	9.0	8.2	8.8	29.9	28.1	28.9	33.8	31.0	32.4	Satisfactory at 600 f.p.m.
I-5	6-23-56	7-2-56	--	28.2	9.5	9.0	9.2	28.1	25.7	26.9	33.0	29.6	31.1	Satisfactory at 600 f.p.m.
I-6	6-23-56	7-2-56	--	28.0	9.5	9.1	9.3	29.9	25.1	28.0	34.4	30.6	31.8	Satisfactory at 600 f.p.m.
Current Machine Average:				27.0			9.1		28.7				32.5	
Cumulative Machine Average:				27.9			9.9		32.2				34.6	
Machine Factor, %:				96.7			91.9		89.2				94.1	
Machine Index, %:				99.9			87.1		88.4				96.8	

TABLE XII

SUMMARY OF TEST RESULTS FOR MACHINE J

July, 1956

Code	Date Made	Date Recd.	Mill Roll No.	Basis Weight, lb. per 1000 sq. ft.	Caliper, points		Concora Flat Crush, p.s.i.		Single-Face Flat Crush, p.s.i.		Runability
					Max.	Min.	Max.	Min.	Max.	Min.	
J-1	6-13-56	6-25-56	56	25.7	9.4	8.8	37.1	28.1	33.9	35.4	33.8
J-2	6-14-56	6-25-56	57	28.7	10.5	9.8	41.9	35.9	37.7	42.4	41.0
J-3	6-18-56	6-26-56	58	27.4	10.9	10.0	32.9	28.1	30.4	36.2	34.2
J-4	6-21-56	6-29-56	59	27.9	10.4	9.5	27.5	24.0	26.1	34.8	32.9
J-5	6-25-56	7-3-56	60	26.8	10.1	9.2	38.3	32.9	35.2	38.6	36.5
J-6	6-27-56	7-16-56	61	27.1	10.8	10.0	38.9	37.1	37.8	37.6	34.5
J-7	7-2-56	7-16-56	62	26.9	10.8	9.0	37.1	34.1	35.9	33.2	32.0
J-8	7-9-56	7-17-56	63	27.9	10.2	10.0	32.9	32.3	32.8	40.2	36.4
Current Machine Average:				27.3	9.9		33.7		35.2		
Cumulative Machine Average:				27.1	10.4		33.1		34.0		
Machine Factor, %:				100.7	94.5		101.9		103.3		
Machine Index, %:				100.9	94.8		103.9		104.6		

TABLE XIII

SUMMARY OF TEST RESULTS FOR MACHINE K

July, 1956

No samples submitted.

TABLE XIV  
SUMMARY OF TEST RESULTS FOR MACHINE L

July, 1956														
Code	Date Made	Date Recd.	Mill Roll No.	Basis Weight, lb. per 1000 sq. ft.	Caliper, points		Concora Flat Crush, p.s.i.		Single-Face Flat Crush, p.s.i.		Runability			
					Max.	Min.	Max.	Av.	Max.	Min.		Max.	Av.	
L-1	6-21-56	6-26-56	52	27.1	11.0	10.1	10.6	30.5	28.1	29.2	33.4	31.2	32.6	Satisfactory at 600 f.p.m. Satisfactory at 600 f.p.m. Satisfactory at 600 f.p.m.
L-2	6-26-56	6-29-56	53	28.0	11.2	10.8	11.0	31.1	28.7	29.8	32.2	28.8	30.6	
L-3	6-28-56	7- 2-56	54	27.9	11.5	10.9	11.1	27.5	22.8	24.2	31.6	30.2	30.9	
Current Machine Average:				27.7			10.9			27.7			31.4	
Cumulative Machine Average:				29.0			10.9			30.3			32.7	
Machine Factor, %:				95.4			100.0			91.6			95.9	
Machine Index, %:				102.2			104.8			85.4			93.4	